WIRELESS DEVICE DETECTION SYSTEM

This application claims priority from and is a non-provisional application of U.S. Provisional Application No. 61/792,155 filed on Mar. 15, 2013, the complete disclosure of which is incorporated herein by reference.

This invention was made with government support under Contract Nos. 2007-RG-CX-K179 and 2011-IJ-CX-K002 awarded by the National Institute of Justice; and Contract Nos. N00014-04-M-0253 and N00014-06-C-0044 awarded by the Office of Naval Research. The government has certain rights in the invention.

BACKGROUND OF THE INVENTION

This invention relates to a system for detecting and locating the place of operation of wireless devices such as cellular phones, and in particular, a system capable of detecting and locating the use of cellular phones in an area such as a prison where radio frequency (RF) antennae have been installed at various locations.

It can be very important to be able to detect the use of and location of wireless devices, such as cellular phones. One particular application where it can be very important to locate the use and operation of cell phones, and in particular, the use and operation of unauthorized cell phones, is in correction facilities. Numerous approaches have been undertaken to prevent unauthorized use of cell phones in correction facilities, but this has become a continuing problem, which has been difficult to address. Phones are smuggled in to inmates by guards or family members and activated using prepaid calling plans that are very hard to trace. Such unauthorized use poses a severe concern as criminals may contact gang members or others to plan and coordinate illegal activities including, but not limited to, buying drugs, elimination or intimidation of witnesses or competing gang members, and/or to plan escape attempts, all while behind bars.

One prior approach for controlling unauthorized dissemination and use of cell phones in correction facilities is to manage and carefully screen access. Such screening measures create additional costs and have been minimally effective. Accordingly, it is an object of the present invention to provide a system and method wherein the use of a cell phone in a monitored area is detected, and based upon the signals detected, the system can calculate and pinpoint or approximate the location where the cell phone or wireless device is being operated.

SUMMARY OF THE INVENTION

In one embodiment of the invention, a device for detecting wireless signals and locating the place of origin in a building is provided that includes a transmitter system using a cellular protocol; a plurality of antennae that receive wireless Radio Frequency (RF) signals, each antenna having a port; a receiving system connected to the antennae ports with a plurality of cables, converting the RF signal to voltage waveform; a processing system in communication with the receiving system, detecting the strength of the received signals and Time Difference of Arrival of the RF signals with respect to antennae and determining the location where the wireless signals are being emitted by using classification algorithms; and a human machine interface.

The transmitter system can be a modem(s) programmed through a computer to send out RF signals to provide training data sequences to the processing system. One of the antennae is denoted as the reference antenna.

The receiving system may have four channels and samples the RF signals and converts them to voltage using aliasing and band pass filtering. The device may further comprise communication means between the receiving system and processing system. The communication means can be implemented using Gigabit Ethernet.

The processing system may consist of a computer and signal processing software, wherein the signal processing software may further include preprocessing software. The preprocessing software filters voltage signals and determines features of the voltage signals. The features of the voltage signals may include signal strength and Time Difference Of Arrival to the antennae with respect to the reference antennae.

The signal processing software may further include classification software. Training data sequences can be used to provide statistical information of features of voltage signals. A supervised classification algorithm may determine the location in which usage of the wireless device occurred. A human machine interface may set an alarm and may provide an operator with visual information of the location in which the wireless device has been used.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and objects of this invention and the manner of obtaining them will become more apparent, and the invention itself will be better understood by reference to the following description of embodiments of the present invention taken in conjunction with the accompanying drawing, wherein:

FIG. **1** is a schematic diagram of the functional components of the wireless device detection system;

FIG. **2** is a map showing a layout of a building being monitored for cell phone use and location of the antenna to receive the transmitted signals; and

FIG. **3** is a bar graph depicting success rate for detection of the use of cell phones in various rooms in the building of FIG. **2**.

Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawing represents embodiments of the present invention, the drawing is not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the present invention. The exemplification set out herein illustrates embodiments of the invention, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings, which are described below. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. The invention includes any alterations and further modifications in the illustrated devices and described methods and further applications of the principles of the invention, which would normally occur to one skilled in the art to which the invention relates.

Now referring to FIGS. **1** and **2**, a system is depicted, generally indicated as **10**, for detecting and locating the source of wireless signals. System **10** includes a plurality of antennae **20**, which are placed at strategic locations in a building, generally indicated as **12** (see FIG. **2**), wherein it is desired to detect the use and location of wireless devices. System **10** also includes a processor card **22** that in one